Appendix P

Method and System for Sequential Charging of Multiple Devices by a Programmable Power Supply

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Background

Figure 1 shows a power supply 100 as known in current art. One example is described in detail in U.S. patent no. 6,266,261 and some related patents. In principle, programmable power supply 100 has a power cord 101 with an ac connector 102, an input port 103, an output port111 with an extension cord 110 ending in special adaptor device 113 that connects to a cable through port 112 to a device such as a notebook, cell phone, PDA, or other similar device on the other side. Adaptor device 113 contains a set of resistors to program voltage and a current limit.

Figure 2 shows examples 113a and 113b of different possible component configurations for a programmable power supply. Simple resistors are used to program the output voltage delivered, in this example on pin 2, with ground on pin 3. Also shown are the details of port 111, a four-pin port (pins 1-4) connecting to internal control device 201 that receives a voltage 202 from the rest of the power supply 100 and, according to which resistors are applied, delivers information back through connection 203. Connections are simplified in this example for reasons of clarity.

The problem with the above-described solution as currently practiced by those skilled in the art is that very often a user travels with multiple devices, such as a digital camera, notebook computer, a cell phone, and a PDA. In such cases, because the power supply can charge only one device at a time, the user must charge each device separately, unplugging any previously charged device and then plugging in another device and its adaptor, even though the power supply may be universally adaptable for all the user's devices. Thus a traveler who has used and discharged multiple devices during a busy day and who hopes to charge multiple devices during the night, must arise during the night each time one device is charged and the next device may be connected to the charger, with attendant switching of adaptors as required. What is clearly needed is a system and method that allows a user to connect all devices to a power supply at one time and leave them unattended, with an assurance that they will all charge properly after some suitable length of time (such as overnight).

Description of the Embodiment

Figure 3 shows one approach for unattended, sequential charging of multiple devices by one power supply, according to the novel art of this disclosure. A charging sequencer device 300 connects at the end of cable 110 coming from power supply 100, as shown in **Figure 1**. Device 300 contains a power-switching array 301 for connecting the power coming in on port 112a to one of the output ports 311 a, b, or c. It also contains analog switching array 302 to pass through the resistor values it sees from the tips 113'-1, -2, and -3 through cables 110a-c and passes them through the analog switch 302 back into cable 110 leading into the power supply 100. Thus each device connected to device 300 is ensured of receiving its correct voltage. In some cases, it may be necessary to take care that in the transition between devices, the new voltage stabilizes without exceeding the voltage range of the next device. For example, one solution could be to first connect the resistors and then the Vout. Another solution could be to let the Vout stabilize to the new voltage from an initial safe low voltage. Also, in some cases resistors and capacitors, or even negative resistors (using operational amplifiers to compensate for losses) may be added for better results. Many variations of dedicated hardware (not shown) may be added to improve functionality without departing from the spirit of the present invention.

The charge sequencing is done by microcontroller 305 , sometimes in combination with dedicated hardware(not shown) , typically some kind of embedded microcontroller as is well known in current art. A small added regulator 303 creates an internal supply voltage for microcontroller 305, because in some cases the input voltage may be too high for microcontroller 305 to operate directly from. Optional current sensing resistor 304 is also added in the ground pin of the input connector 112a, thus allowing the microcontroller to sense when a device has finished charging by observing a dramatic drop in the steady-state current. The microcontroller can then tell the charger 300 to revert to a trickle charge or pulse standby charge pattern. When the end of charging is thus recognized, charging power can be shifted to the next device, and so forth. When all the devices are charged, a trickle pattern can be implemented that, for example, gives each device 5 or 10 minutes of trickle charge and then switches to the next device.

In some cases (not shown), the microprocessor may also have sensing capabilities to detect insertion or removal of devices. In the simplest case, a current-sensing resistor may be used, as described above, but other detection methods could also be used. This approach typically would result more efficient operation,

because unused branches would be skipped. This approach could also be used to supply state indications to the user interface. For example, an LED could indicate "Device 2 is plugged in and is waiting to be powered." Also, various behavior and properties of the devices may be tracked and this information may be used for the power sequencing routine.

In some cases, the user may be offered the opportunity to input patterns of charging sequences among the various devices plugged into the charging sequencer device 300. In other cases, the charging sequence may simply start at the first port (e.g., port 311a) and proceed in order through the port sequence (e.g., port 311a to port 311b to port 311c). Thus the user can control the charging sequence by plugging devices into the ports in a specific order. Or there may be a user sequencing input 306, which may be as simple as a push-button, or it may be a more complex user interface (not shown), such as multiple push-buttons, selectors, LCDs, LED displays, audio indications, etc.

Sequencer 300 may be offered as an after-market upgrade for existing programmable power supplies of the type described in the background section of this disclosure. However, in other cases, the sequencer may be integrated into a new power supply 400 as shown in **Figure 4**. Power supply 400 in essence contains the building blocks of the original power supply 100, the programming controller 201, and the multiplexing device 300. It is clear that economies of materials and manufacturing effort may be achieved by integrating all functions into one unit.

Further, in some cases, the resistors and the 'tips' may be already embedded in the device and the device may have a standard universal power port. Also, doing the switching using a user control mechanical (e.g., rotary) switch to switch between devices may be implemented. In yet other cases, or in combination, the system may have the ability to charge multiple devices at the same time if they are using the same voltage. Such multiple device charging may be done by sensing the resistors and detection matches of voltage and total power. In some cases, the system may include other than just resistors for communicating the voltage and current requirements. Further, in some cases a method may be used wherein the microcontroller reads the device parameters and passes them onto the power supply (either in the same format, such as resistance, or in a completely different format). In yet other cases, a multi level or modular system may be implemented, in which a sequencer (such as device 300) is installed at one of the branches of another sequencer. Further, a sequencer can be implemented where the input or output wires

are automatically retraceable, or can be wound around the body of the sequencer, rather than just plugged in. Also, a sequencer can be made that is an add-on attachment to an existing power supply. Further, a sequencer might also have a container for storing the tips. In yet other cases, a sequencer may include various travel and other types of accessories (emergency light, alarm clock, smoke detector, etc.). A sequencer may also act as a battery charger. For example, the sequencer could have a place to insert two AA rechargeable batteries. In yet some cases, a sequencer may use a fixed voltage power supply, so it could then support either sequential or parallel powering of devices of the same voltage. For example, a manufacturer may use a standard 5V operating voltage for multiple products, so the sequencer could be used to charge all these devices sequentially.

In some cases, the LEDs or other indication can signal to a user so he can clearly see the status of each device. Further, specific information may be displayed for error conditions such as the voltage required by a device does not match the power supply capabilities, under/over voltage etc.; in yet other cases, in the sequencer voltage adjustment and splitting capabilities could be added, for example, having a DC/DC from the main rail such that a notebook and a PDA can charged at the same time. Attached with the present application are Appendices A through O, which are incorporated herein by reference.

MoW19

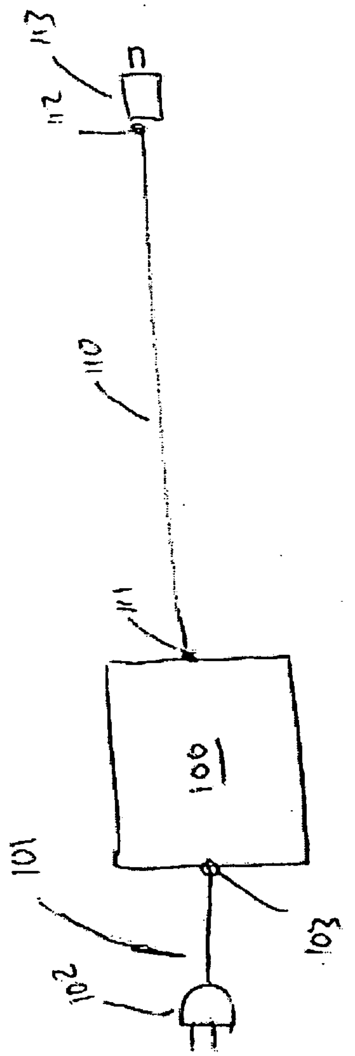
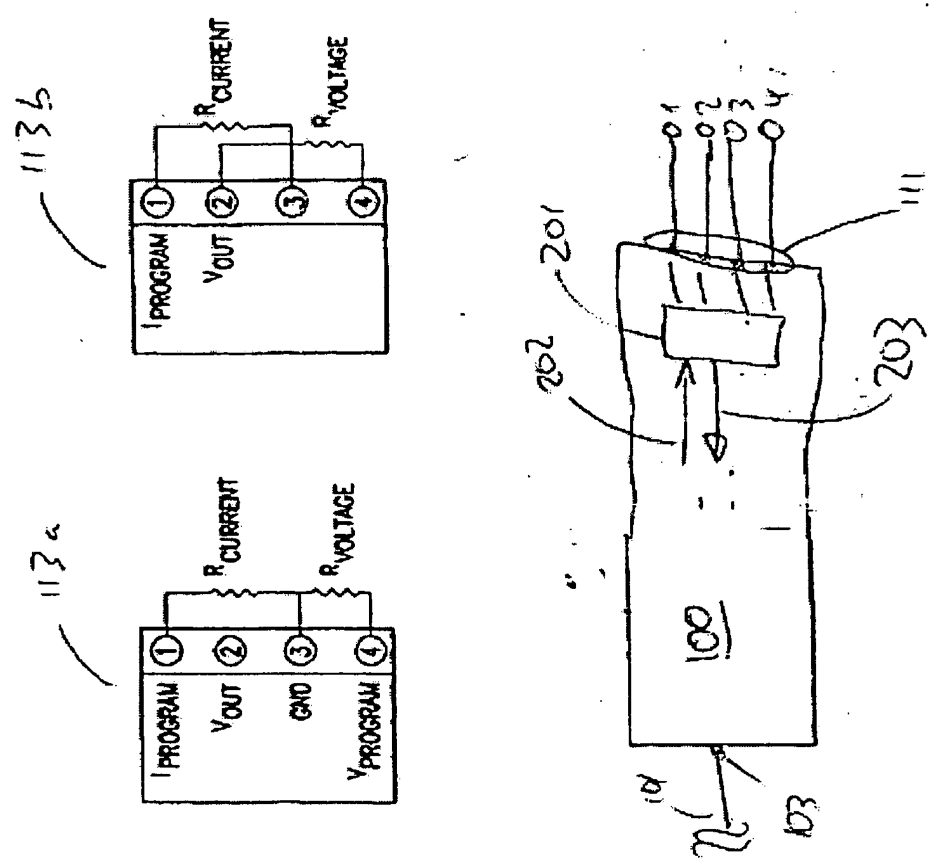


Fig. 1


113b
I PROGRAM
V OUT
R CURRENT
R VOLTAGE
113a
I PROGRAM
V OUT
GND
V PROGRAM
R CURRENT
R VOLTAGE
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2
3
4
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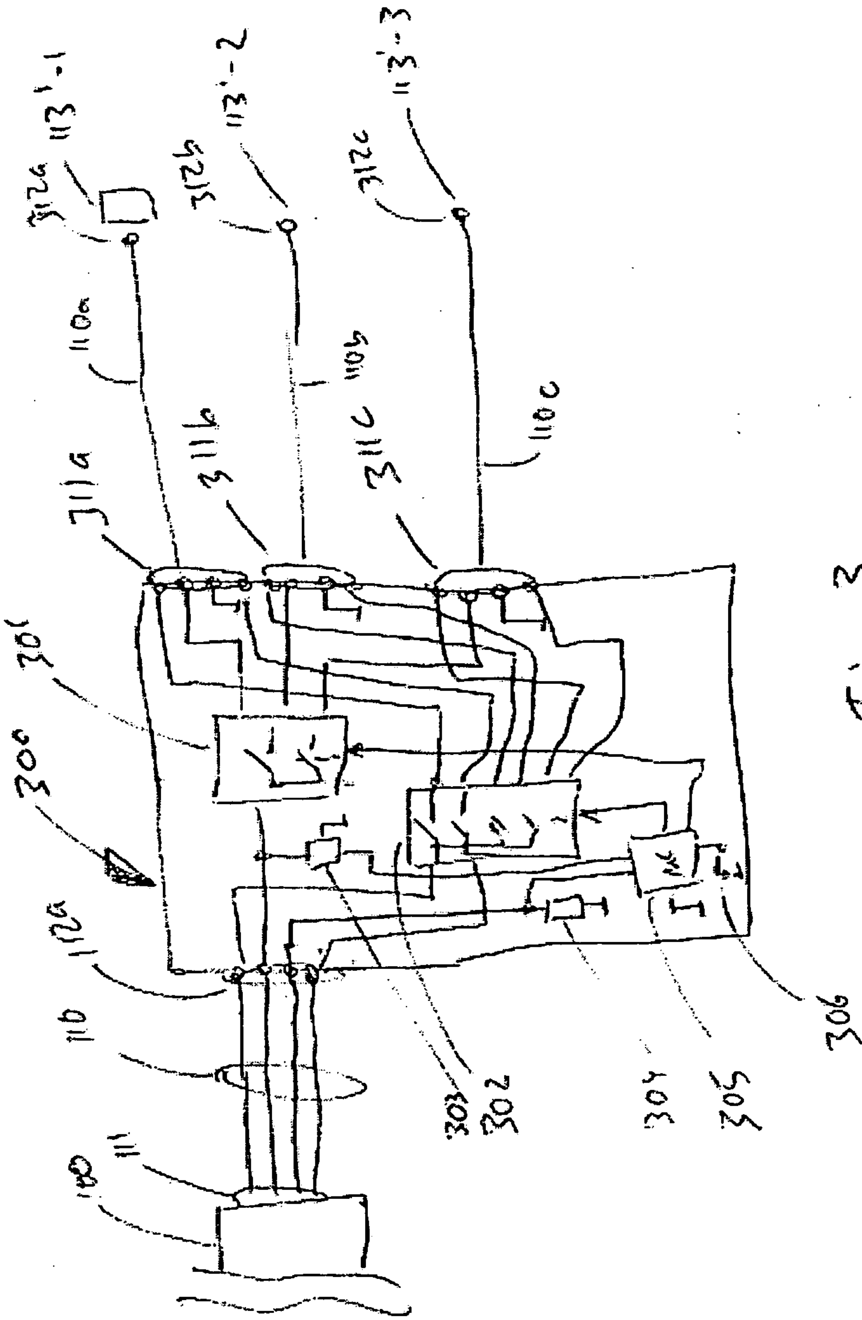
202
203
111
100
101
103

Fig. 2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113'-2
113'-3
312a
312b
312c
110a
110b
110c
311a
311b
311c
301
300
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302
304
305
306

Fig 3

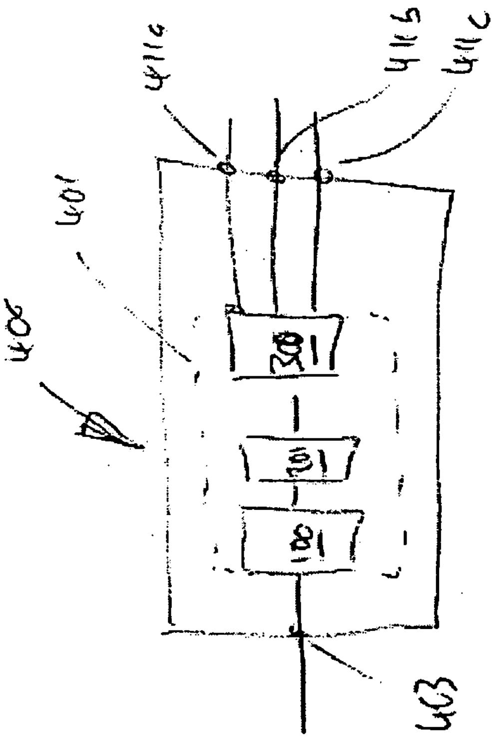

Fig. 4